PillowTalk: Can We Afford Intimacy?

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ABSTRACT
This paper describes the *move.me* interaction prototype developed in conjunction with V2_lab in Rotterdam. *move.me* proposes a scenario for social interaction and the notion of *social intimacy*. Interaction with sensory–enhanced, soft, pliable, tactile, throw-able cushions afford new approaches to pleasure, movement and play. A *somatics* approach to *touch* and *kinaesthesia* provides an underlying design framework. The technology developed for *move.me* uses the surface of the cushion as an intelligent tactile interface. Making use of a movement analysis system called Laban Effort-Shape, we have developed a model that provides a high-level interpretation of varying qualities of touch and motion trajectory. We describe the notion of *social intimacy*, and how we model it through techniques in somatics and performance practice. We describe the underlying concepts of *move.me* and its motivations. We illustrate the structural layers of interaction and related technical detail. Finally, we discuss the related body of work in the context of evaluating our approach and conclude with plans for future work.

Author Keywords
social intimacy, tactile interface, somatics, movement analysis, Laban effort-shape, tangible UIs, art/design installation, play, social interaction, user experience, ambient environment, choreography of interaction.

ACM Classification Keywords
H5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

INTRODUCTION
A growing trend within tangible and embedded interaction is a desire to express emotional qualities through interaction, accompanied by an interest in incorporating movement and human perceptual-motor abilities [18]. Within HCI, *intimacy* is among an emerging set of experiential values that also include curiosity, enjoyment, resonance, play and self-awareness [6]. Hummels, et al [18] describe this trend as a renewed 'respect for the human as a whole', and cite the shift in contextual focus of HCI from the work place to 'quality of experience' in our everyday lives. A direct reflection of this contextual refinement is the development of interactive technologies that mediate intimacy [14, 20, 28]. The expression of *intimacy* is vital in personal and social interaction. It is reflected in the persistent desire to create technologies that simulate touch, body contact, and 'near-space' interaction [20], and that communicate closeness, even at a distance [16]. Gibbs et al [14] have coined the term 'phatic technologies' to emphasize the qualitative importance of non-informational forms of exchange: interactive technologies that are less concerned with capturing and communicating information and more involved with establishing and maintaining social connection. Grivas [16] argues similarly that assigning aesthetic and emotional qualities to physical objects or locations is a key strategy for the achievement of intimate interactions. Intimacy is connected with physical togetherness and contingency, and that intimacy can be heightened by a 'post-optimal' approach to technology that values the evocative and poetic powers of electronic media over the urge for utility and efficiency. Gaver [13] reflects on intimacy and emotional communications systems by asserting that new forms of aesthetic pleasure can evoke a deeper and richer experience through increased use of unusual and sense–based materials and interactions, and less 'explicit' forms of information, encouraging imagination and expression of value and attitude.

We propose the notion of *social intimacy*, where the interplay between people and a set of networked objects in a social or public space can be used to create awareness between others, sensitivity and more vital connection between groups of people in a public space. As a part of the European ITEA Passepartout project (www.passepartout-project.org) we explore *intimate* ambient technologies in the context of home, and *social-intimacy* in urban social spaces, such as a lounge, café, or *speak-easy*. We have developed a set of small interactive throw pillows containing intelligent touch-sensing surfaces, in order to explore new ways to model the interactions and experiences of participants and artefacts within the environment, in the context of expressive non-verbal interaction. Key concepts investigated by *move.me* include intimacy, connectivity and play.

We apply 'phatic'[14] approaches to technology, using networked cushions to explore awareness of connection and playful interaction. We use aesthetic properties of materials and their innate sensuality coupled with movement and pleasure to support *socially intimate* connectivity, including interactions of empathy, peripheral awareness, and engagement, as portrayed in Figure 1.

Figure 1. Interactive Pillow as Intimate Object – Paris ITEA demonstration Oct 2006

We propose ambient technology that requires the ability to detect and understand the user's activity, body state and identity [2]. Additionally, it has to understand the social signals displayed in user communication, as the this is always part of a larger social interplay [15].

This article first describes the motivation for our choice of the pillow as an everyday intimate object We then outline the underlying concepts of *move.me*. We illustrate an in-depth look at the structural layers that support the representation of context within *move.me* and related technical detail. Finally, this work is placed in the context of related bodies of work for evaluating our approach. We conclude with plans for future work.

THE PILLOW AS AN INTIMATE EVERYDAY OBJECT

The pillow is an example of an intimate everyday object. A pillow can express and extend a large dynamic range of qualities of affect. Our interaction can range from affection to ambivalence in a continuous cycle within our daily lives. Warhol's "Silver Floating Pillows" and Dunne's "The Pillow" [11] have contextualized the form of the pillow in both art and design. While Philips "photonic pillow" [23] is an extension of display of a 'soft' SMS, Dunne and Gaver describe "the Pillow" as a soft, subtle, gentle emitter of ambient data, beautiful and evocative, raising its issues and its content gently, one that has a certain *value fiction* that can contextualize information about our environment (in their case: the presence of electromagnetic radiation) through immediacy, intimacy and simple pleasure. The pillow is familiar: it contains our memory, energetically and physically. Pillows have a rich and evocative metaphor space: they cushion us, bolster us when we are nervous, can be cherished, warm, close, and friendly. A pillow keeps secrets and shares intimate connections [25]. The term Pillow Talk and Pillow Book both reference this secret internal world of the body, the sensual or even erotic connotations that the pillow can suggest. Pillows are used as forms of urban or folk combat: the pillow fight, a physicalization of battle, physical play and expression of affect. They enable both the internalization as well as the externalization of movement, and 'afford' interaction that can play or slide between these varying scales. But a pillow is also a safe and humble object, it is held by a child for safety, for comfort, and to 'bring a sense of home' along for the ride.

Our exploration of the pillow as intimate technology embeds both digital technologies along side metaphors of intimacy to allow us to share, edit and communicate the evidence of our connection to reflect more subtle – or poetic – aspects of our identity and connection through patterns of touch, movement and being. We communicate embodied intimacy and play through a tactile interface embedded in the textiles and in the fabric of the cushions. In this way both the circuit design and the fabric and textile becomes an aesthetic component of the interactive object. [5]. This is also an extension of awareness technologies as discussed in Gaver's [13] reference to provocative awareness.

MOVE.ME – MOTIVATION AND SCENARIOS

Move.me is an ambient environment in which *embedded technologies* act as a "connective tissue" between users and devices within a contextualised space through domain-specific interaction strategies.

In *move.m* we developed a set of small interactive throw pillows, as portrayed in Figure 2. We utilize these pillows within two scenarios, a home scenario where a pillow is used by a single user in the context of digital entertainment, and in a café or lounge environment where the ambience is created by the dynamic social activity and interaction of people coming and going.

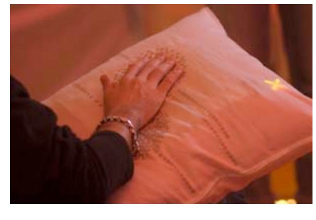

Figure 2. Pillow with actuators, touchpad, LED display and vibrator (photo courtesy of Jan Sprij).

The home scenario explores a child as the interactor with the pillow. In this scenario the media space is understood as an experience space, which the child can explore freely. Thresholds can be set for this space, with respect to levels of excitement, as well as temporal aspects such as the reaction time for adaptations. The aim of this scenario is to explore a single user single object interaction and its possibilities to influence the overall environment.

The second *move.me* scenario is situated in a café/lounge environment, where participants are invited to re-mix a set of moving images projected in large scale on the walls within the café through physical interaction with a set of small interactive pillows. Figure 3 portrays a setting of the *move.me* environment, on the left, and an action performed with a pillow, on the right.

Figure 3: The *move.me* scenario setting.

The type of purpose-free social play in this scenario forms a kind of choreographic experiment in which the result of interaction with the pillow creates movement on at least three levels: 1) the movement of the participant as they interact with the pillows (touching, caressing, throwing, hitting, holding); 2) the movement of the pillows themselves as a result of the participants interaction; and 3) the movement of re-mixed images derived and rematerialized in direct response to the public intervention. The focus of this work lies on the representation of movement in an environment that is aware of users and objects but not necessarily knows much about them. This work integrates somatics [17] and gesture interaction [21] with textiles and interactive object design [25]. A detailed description of this environment can be found here [3].

SENSORS, ADAPTATION AND FEEDBACK IN *MOVE.ME*

The main idea behind *move.me* is to establish an environment, which constantly collects raw data from various modality-sensitive objects that is then communicated to a context engine. The context engine interprets the derived parameters to manipulate in turn the presentation of audio-visual material displayed in the environment as well as the overall ambience of the environment itself, e.g. by manipulating light and sound sources.

As a result we developed an interaction model that involves three parts:

- The user.
- The interface, which in our case is a conceptual unit containing the interactive pillow as input sensor and other devices, such as vibrator, fan, light-emissive fibre, light-emissive diode, earphones, screen, sound system, lamp, et cetera, as output sources.
- The context engine as a back end server.

With respect to its interaction part the model extends Don Norman's traditional execution-evaluation model [22] beyond the user's view of the interaction by including not only the interface but all the elements necessary to judge the general usability of the interactive system as a whole. This allows placing the *move.me* environment in different social contexts with an overlap on a particular task.

With respect to the contextual aspects of our interaction model we adopt strategies from case-based reasoning (CBR) [1], in particular those strategies which argue that tracing the history of actions [9] provides the means to improve a systems capability to adaptively interact with a user. We establish a set of raw data, on which we then elaborate based on user and environmental data (both together form our context) to perform contextualized adaptation. The adaptation as well as the context it was performed in are then stored and will be used in the ongoing process of ambient user adaptation for further refinement.

In the remaining part of this section we will outline the various modules of the *move.me* environment, namely:

- *Sensors*, which are the input sensors of the pillow.
- *Sensor evaluation module*, which instantiates the device drivers for every detected pillow. Its main task is to perform some statistical analysis (high-pass filtering and mean value calculations) in order to keep the overhead of processing low.
- *Context module* that consists of data structures describing the current context with respect to users, devices and the interactions between them.
- *Adaptation engine*, which uses data from the Context module to establish a mapping between detected actions and the appropriate environmental adaptation. It also conveys instructions about the source to be adapted and the means of adaptation to the Communicator.

We are aware that a number of the described action efforts as well as resulting adaptations could also and probably should be detected by other devices than the pillow. However, for the sake of clarity we explain the mechanisms through the pillow.

Pillow sensors and their evaluation

The objectives of the technical research in *move.me* are twofold. First, we want to explore smart fabric textiles in the context of flexible electronics and displays in order to build these into a wireless network, capable of making body data available. Second, we wish to develop heuristics of interaction based on touch, gesture, and movement to infer action efforts from users while utilising the device and to manipulate this raw data to enable a higher-level mapping of action efforts and presentation manipulation techniques.

Using raw data from smart fabric textiles allow qualitative recognition for two categories of movement: 1) touch on the surface of the pillow, and 2) movement in three-dimensional space created by the 'free-throwing' of the pillow. We call our touch selection input "threads of recognition" because it refers to metaphors of input recognition in the context of smart textiles research [24].

Pressure is the essential type of data we process to extract a caress and its effort. We have identified a set of parameters that can be extracted or calculated from the information that the response area provides over time. These parameters are described in Table 1. At the moment we utilise the values for pressure, size, speed and direction as input parameters.

A pillow in *move.me* is the main medium for smart fabric textiles, and can be equipped with any of the sensors and actuators as displayed in Figure 4.

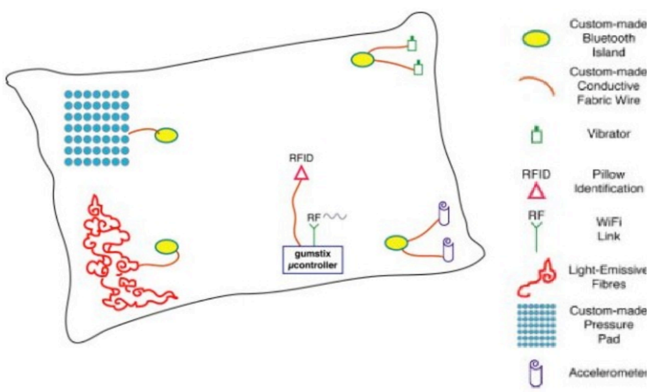

Figure 4: Pillow technology

The main sensors we apply are a touch-based interface for measuring pressure and accelerometers to measure motion. Fans, vibrators and light sources, either in the form of light emissive fibers or as a LED display, provide localized feedback.

The touch-pad itself is a simple grid (64 sensitive regions) of carbon-impregnated open cell polyethylene foam. This material has the characteristic that the electrical resistance of the foam drops as the density of the foam increases. We utilize this behaviour to identify a point of contact or applied pressure.

The processing unit is a small, lightweight, single-board computer, which connects to the accelerometers, and a sensor board card, which can measure up to 64 pressure sensors. The computer filters the incoming data and communicates at a rate of approximately 20 Hz to the server application, where the interpretation of the data is performed. When switched on, the pillow propagates its IP-address and port number on the network, which allows listening programs to detect and register the pillow and start receiving or sending messages.

For identifying users in the closer surroundings of the pillow each pillow contains an RFID reader/writer, allowing us to write our codes into programmable RFID-Tags, which are embedded within each pillow or worn by users of the environment as bracelets.

Parameter:		Description
pressure	soft-hard	The intensity of the touch.
time	short-long	The length of time a gesture takes.
size	small-medium-big	The size of the part of the interaction objec that touches the pad.
number	one-many	The distinction between one finger or objec and many fingers.
speed	none, slow-fast	The speed of a touch-effort. This is the overall velocity of movement. This parameter is not used directly to distinguish efforts, but is used to determine space.
direction	none, left, right, up, down, and four diagonals	The direction of movement. This paramete is not directly used to distinguish efforts, bu is used to determine space and path.
Secondary:		
space (speed)	stationary-traveling	A function of speed. If speed is zero then the gesture is stationary, otherwise it's traveling.
path (direction)	straight-wandering	If the speed is not zero, and there is only one direction registered, the gesture is straight.
disposition (pressure)	constant-varying	If the pressure maintains a single value after an initial acceleration the gesture is constant otherwise it's varying.
pattern (gesture)	continuous-repetitive	If a gesture is unique in relation to the gesture immediately before and after, it is continuous. Any repeated action or gesture is classified as repetitive.

Table 1: Parameters derived from pressure pad data

Emphasizing the sensual aesthetic of a pillow, covers are designed to encourage connection through feel in an associative and intuitive way. Pillow prototypes are portrayed in Figure 5.

Figure 5: Prototype pillows

Pillowcases are made of silk organza [24], a conductive fabric. In *move.me*, we use this material as cables that send data signals from the touchpad to the embedded processing unit. In that way we achieve that users, such as children, not only interact naturally with the pillow but also whish to do so, as the surfaces of textiles or light-immersive material asks for touch. Moreover, all the required hardware is lightweight and wrapped in soft material to avoid edgy sharpness that could destruct the intimate character of the pillow.

The pillow serves mainly as an affectionate transmitter that provides a basic analysis of the signals, e.g. calculating time and space variables, which are then sent out to the central system along with additional information, such as which other pillows or users are near to this pillow.

Once the data for pressure, size, speed and direction is received by the central system, the sensor evaluation module performs a first abstraction on the data. The way that incoming sensor data is analyzed depends on the context and the configuration of a pillow. For example, if the pillow contains a pad that allows measuring pressure as well as galvanic skin response (GSR) and an accelerometer for computing movement, a different abstraction scheme is provided as output compared to a pillow that only contains a pressure pad. This means that the system handles every pillow individually, as it also does for users. Only at a later stage are the individual views combined to the global context view.

When analysing streams of data, in this case the input data for every taxel of the pad, it is desirable to keep a history of past events especially when we are looking for trends in the data [12]. However, storing the whole dataset and re-iterating over the last *n* samples whenever a new sample arrives quickly becomes inefficient as *n* grows. We, therefore, apply a method that keeps a history of past events without actually storing them but summarizing instead the entire set of (or the last *n*) past events in a few critical parameters.

For the detection of the pillow movement we analyse the data coming from a pillow's accelerometer. The basis of the recognition is a distinction between linear movements in three directions, clockwise and counter-clockwise circular movements, as well as rectangles and triangles described in space. The collected raw data is interpreted as vectors, and the input vector (the "raw" acceleration vector) is filtered and further processed to subtract the influence of gravity, and to yield "Position" and "Orientation" vectors. The "Motion" vector (i.e. total acceleration - gravity = acceleration caused by movement) is passed on to the neural network for the analysis of pillow motion (twirl, pan, tilt). The interpretation of the sensor data depends on the context in which it was collected.

Context in *move.me*

Context in *move.me* describes an area, namely a living room (home entertainment context) and the lounge (café context), in which users interact with the pillows.

The **Context Module** describes the current (present) status of the environment with respect to resident users, devices and the interactions between them. Users as well as devices become part of the Context Model once their RFID is detected. For each detected user or object a memory structure is established that reflects only those characteristics that are relevant for the current context. User characteristics are, for example, the user identifier, relevant thresholds, the current biometric status as well as related presentation devices. Device characteristics are, e.g. the device's sensor set, its affector setup, the device IP, activity state and location as well as preferences for particular users.

That we provide devices with a memory structure that is similar to that of human users is so that they themselves become proactive towards users. At the moment we only store very simple data, such as user id, action performed and its duration, but later on we wish to explore further in that direction.

The memory structures are rather static schema with which it would be difficult to observe the dynamics of the environment. We introduced, therefore, the concept of a session, which monitors the interactions between a user and device or between devices. A session is a structure containing the ids of the two agents involved, the general start time of the session, the end time, the actions performed and resulting status reports (e.g. sensor values).

A session is instantiated by the Context Module once a device detects the user id and its sensors show some level of interaction. Sessions between devices are instantiated if a device in another session acts as a meta-device. Example: a child might hug a pillow (session A: child1 – pillow23) while it watches TV but actually operates through the pressure it performs on it the presentation of the program (session B: pillow23 – loudspeaker). Sessions are closed, depending on the device, either once the interaction stops or if the user leaves the context. In cases where more than one user is detected by a device the one using the device the longest is considered the prime user. If the prime user leaves the context then the next longest user in the list takes over. Once a session is terminated it will be stored in the History Model.

The **History Model** is our approach towards an individualized long-term memory of the interaction patterns for every user and device in a context. It is updated if a user or device exits the context or if a session has been terminated. The model contains, at the moment, two memory sets, namely **identification** and **session**. The identification set is always instantiated once a user enters a context. This set serves as a crosscheck source for the Adaptation engine to evaluate user behaviour (it might turn out that the user attends certain contexts, thus shows interest, but does not act in them – no sessions with this user id in the same time span). The session set describes every interaction the user or device was involved in. The data set stores the collected biometric data and the adaptation list contains the adaptations performed by the Adaptation engine based on the data in the same time frame. At the moment we keep track of sessions, and thus make them accessible to the Adaptation engine, in the form of a relational database. The outlined representation structures serve as sources for the Adaptation engine to determine if an adaptation is required and which type of adaptation needs to be performed.

Adaptation and Feedback

In *move.me* the Adaptation engine uses a finite state machine (FSM), where the session structure and descriptions of the Context module are used as to represent the states. Changes of theses states are triggered through the input devices' touch pad and accelerometer. The transitions are based on the constraints set for the context as well as in the user models. Actions finally describe the adaptation that is to be performed at a given moment, either in the form of the adaptation of a pillow's actuators, such as vibrator, fan, or light-emissive diodes, or the performance of presentation devices in the environment, such as a change of the noise level. Each context can be understood as a set of possible actions and moods that then again trigger certain adaptations. Thus, the organisation of rules in *move.me* is based on context scripts.

The Adaptation engine constantly evaluates the Context module for every identified user and device and reacts on changes only if they are outside the provided constraint set.

In *move.me* adaptation focuses on three major processes, namely stimulation, relaxation and representation. *Stimulation* describes the attempt to either engage a non-active user into an interaction with the environment or to increase a low-base activity. *Relaxation* tries to reduce the amount of activity or excitement. *Representation* aims to present the state of the environment and the user in a visible and audible form.

A typical situation for stimulation in the home scenario is, for example, if the child is in the living room but either does not interact with anything, i.e. simply sits on the sofa (the child is detected by the system but no session is established); or the child might hold the pillow but does that for a long time without changing neither effort nor gesture (there is a session instantiated but the changes of values are infrequent and generally low).

If the Adaptation engine cannot identify a session it tries to engage the child. The first step is to investigates which type of devices are available that are equipped with actuators that provide means to connect with the child (e.g. all types of global actuators, such as LEDs, emissive fibers, loudspeakers, etc.). Comparing the neighbourhood relations between these objects and the user the adaptation can activate the closest non-active pillow to start an interaction with the user. However, if any of the pillows already has a preference for the child, as represented in the pillow's user model, or the child has a preference for any of the pillows, this particular pillow will be instantiated to become active. In that way our system tries to utilise already established relations between objects and users. The start of an interaction can begin with already established pattern, such as the pillow shows known visual pattern that invite the child to hug the pillow. Once the contact is established the adaptation engine will use other established relations to stimulate further interest, e.g. switching on a TV or radio program.

A different type of stimulation is the detection of potential non-interest. Assuming the adaptation engine discovers over a period of time (a constraint determined by the context) a steady decrease of one of the threshold values, it might determine that the user is bored, and it may then activate both an icon on the LED matrix in the centre of the touch-pad, as well as causing a vibrator within the pillow to generate a shiver-like action. This pattern might also be used to instantiate a change of context, for example the change from TV mode into game mode.

The order of rules for the Adaptation engine is established based on the current state and the outcome of tracking the performance of the instantiated adaptation. In the example of the change between the state of watching TV and playing a game the adaptation engine would not launch the game if the child had not responded with acceptance of that change in time. In case the child ignored the suggested game, the Adaptation engine would try another strategy, e.g. instantiate a change in the environment, like increasing the volume to attract attention.

The dynamic interpretation of user actions and its efforts as well as pillow movement results in a change of visual and auditory patterns as well as task contexts, which in turn might stimulate new associations in users, resulting in a behaviour that might require that new adaptations be performed by the system. The result is a constant feedback loop where the data from a pillow triggers the interpretation mechanism, which directly affect the audio-visual outputs of the system and vice versa.

EVALUATION

We ran a small user study on the initial prototype of the system, consisting of a qualitative elicitation study, in the form of a one-day participatory workshop with 10 users, which was designed to explore user needs and system requirements. The test users were representatives of the target user group, 3 females and 7 males between the ages of 20 and 30. Aiming to gain an insight into interaction patterns, the workshop covered:

- A hands-on free exploration session with a medium-fidelity pillow prototype (the hardware as well as adaptation software for different modalities worked in real time). The free exploration sessions were conducted first from an individual starting point, and latter on a group basis.
- A "Wizard of Oz" simulation of the complete intended functionality of the system.

The participants' experiences with the pillow through the free exploration of the *move.me* system, and the discussion during the 'Wizard of Oz' sessions were both video taped for later analysis. A detailed evaluation of the workshop is described here [3]. The major findings of the workshop were:

- The current architecture is stable.
- Even though the adaptation of iconic messages on the LED display responded too slowly, causing in some users the impression that the icons were randomly generated, the initial exploration interaction pattern lead to the users' full engagement with the system.
- The way the gestures were performed by the users implied that they do not make a distinction between gestures based on the size of the area on the touch pad occupied by the gesture. For example a tap and a slap meant the same to them. A more important mean of distinction was, however, the number of repetition of

movements or the strength (or intensity) in which they were performed.

We are not only aware of the fact that the pillow is still a limited prototype (even if the current system is stable), but also that the test sample is rather small. That is the reason why, at the moment, we were only able to perform a qualitative evaluation of the system. This means that the findings should be taken as general guidelines, which will allow us to make educated decisions from a user centric point of view for further developments.

A presentation of the pillow functionality at the ITEA symposium in October 2006 showed that the adaptation based on stimulation, relaxation and representation is sufficiently sound to let users understand how the environment reacts to their actions. However, the performed user sessions are again too short to provide significant statistical data about the effectiveness of our suggested context representation. Regarding possible quantitative tests, we are aiming for a later workshop as the basis for fine-tuning the system before the public presentation of the installation in spring 2007 at the Dutch Electronic Arts Festival.

RELATED WORK

In our work we apply sensing and biofeedback technologies to establish a new way of interpreting human movements in real-time to enable expressive non-verbal interaction in the context of ambient, public, urban, social spaces. This section includes a summary of background and informing works.

There has been a great deal of general research in sensing and biofeedback in human-computer interaction [2, 8, 19, 20] Although we use these technologies in different environments, this research has indicated that a number of well established sensory methods, such as pressure and GSR, obtain a window into the state of an individual.

Buxton et al [7] provides early descriptions of the unique characteristics of touch tablets relative to other input devices such as mice and trackballs. Chen et al [10] describe the use of a touch-sensitive tablet to control a dynamic particle simulation using finger strokes and whole-hand gestures, where the gestures are interpreted as a form of command language for direct manipulation. The fabrics used in our work differ, though, as they can be multiple-touch. In our work we go beyond direct manipulation by language to including the quality effort into the recognized gestures.

The Laban notation [21], which we use in the public, urban, and social space scenario of move.me, has often been used to interpret user movements, especially in interactive artistic settings. Badler [4] presents a digital representation of the specific Laban notation. Zhao [30] has applied Laban Movement Analysis (LMA) to studies of communication gestures. Within *move.me* we interpret gestures, or rather users' effort, for establishing communication rather than precise communication acts. Schiphorst et al [26] describe the use of kinematic models to represent movements. Calvert et al [8] further describe the development of the composition tool into the product Life Forms, which uses Laban notation as the representation language. A computer-based graphical tool for working with the similar Benesh Movement Notation is described by Singh [27]. The current work was influenced by the choreographic approach to motion description and presentation of these studies.

Haptics and touch have been explored by many researchers. The University of Tsukuba has also developed a great number system that makes use of haptics such as finger/hand manipulation and locomotion [19]. Although these systems use different technologies, they have provided us with a motivation for the usage of touch.

With socio-ec(h)o [29] we share the notion of play. Just like *move.me*, socio-ec(h)o explores the design and implementation of a system for sensing and display. However, socio-ec(h)o bases its interaction models on existing serious game structures, where body movements and positions must be discovered by players in order to complete a level and in turn represent a learned game skill. In *move.me* the emphasis is more on the entertaining, purpose-free aspect of play than on the learning of skills.

CONCLUSION AND FUTURE WORK

We have described *move.me*, an ambient environment in which a set of small interactive throw pillows containing intelligent touch-sensing surfaces allow the exploration of new ways to model the environment, participants, artefacts, and their interactions, in the context of *social intimacy* through expressive non-verbal interaction.

The novel aspect of *move.me* is the approach to map efforts of actions to higher-level adaptation activities, which opens the mapping space between biometric data and its potential meaning. Though the first prototype shows promising results, we have to provide significant improvements with respect to adaptation response time as well as the range of adaptations to facilitate an experience-rich environment that reflects the broader motions of social interchange. We also have to fine-tune the relations between context, action and presentation modalities and the relationships between intimacy within the context of a one-to-one connection and within a group.

We consider *move.me* as a platform for the study of new forms of ambient-based interaction that integrate networked connectivity, in the context of *social intimacy*, and intend to explore this avenue further.

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